VOLUME X. NUMBER 1

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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PUBLISHED MONTHLY

January, 1916

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.
FOREIGN AGENTS: WILLIAM WESLEY & SON
28 ESSEX ST., STRAND, LONDON.

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$2.00 per annum. Single numbers, 25 cents.

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THE ORBIT OF THE SPECTROSCOPIC BINARY *A* BOÖTIS*

BY REYNOLD K. YOUNG

THE binary character of *A* Bootis (α 14^h 14^m, δ + 35° 54′, type *G5*, Mag 5·7) was announced by Moore in Lick Observatory *Bulletin* 123. Forty-two spectrograms secured at this observatory with a one-prism spectrograph have been used in determining an orbit. In this, as in many other cases, the Lick Observatory results have been useful in defining the period. The details of their observations were very kindly communicated by mail.

In general an orbit of a late type star determined with a one-prism instrument does not compare favorably with an orbit of the same star based on three-prism results. The accuracy is so much greater in the latter case that the practice has been generally followed of leaving the late types for high dispersion. However, the range of the present binary permits of a fairly accurate determination of the orbit with a one-prism instrument. On this

* The details of the observations of this star will appear in the *Publications of the Dominion Observatory*.

account and also because at the time the number of available binaries was rather limited, the star was placed on the observing program here.

TABLE I.

Element	Wave-Length	Correction	Algebraic Residual	Arithmetic Residual	Number of times Measured
Fe	4005·426	− ·037	− 2·8	4·4	24
Fe	4045·975	+ ·011	+ 0·8	1·8	4
Fe	4063·756	+ ·114	+ 8·4	8·4	4
Fe	4071·939	− ·004	− 0·3	2·7	10
Fe +	4092·737	− ·023	− 1·7	4·1	36
V	4116·643	+ ·041	+ 3·0	5·9	16
Fe-Ti	4123·748	+ ·033	+ 2·4	4·7	13
Fe	4127·992	− ·029	− 2·1	4·1	27
Fe +	4132·361	+ ·021	+ 1·5	3·3	22
Fe	4191·697	+ ·011	+ 0·8	3·3	20
Fe	4202·294	− ·032	− 2·3	5·2	33
Fe	4236·057	+ ·013	+ 0·9	4·3	17
Fe	4250·616	·013	− 0·9	3·3	29
Fe	4258·605	− ·010	− 0·7	1·5	6
Fe	4271·829	+ ·006	+ 0·4	3·1	40
	4275·119	·003	− 0·2	3·3	18
Fe-Ti	4282·722	+ ·027	+ 1·9	4·2	36
Cr	4289·766	+ ·003	+ 0·2	3·0	34
Ti	4314·866	− ·010	− 0·7	4·0	30
	4323·612	+ ·073	+ 4·8	7·1	15
Fe	4325·792	·003	− 0·2	4·8	12
Fe	4404·890	− ·004	− 0·3	4·0	37
Fe	4415·225	+ ·007	+ 0·5	3·9	40
Fe	4430·469	− ·023	− 1·6	3·7	35
Fe-Mn.	4462·037	− ·029	− 2·0	4·6	27
Fe-Ti	4549·766	+ ·015	+ 1·0	4·4	33
Cr.-Ti	4571·891	− ·009	− 0·6	4·3	39

Table I. gives the wave-lengths of the lines used in reducing the measures. The corrections in the third column are computed to make the sum of the weighted residuals of column four vanish. The residuals were taken in the sense observed minus the mean of the plate. If we compute from Rowland's Preliminary Table of Solar wave-lengths the lines which would, in one prism disperson, lie near these, we find that the wave-lengths given in the table are about 0·03 Ångstrom units larger. The method of combining the various lines in a high-dispersion table is arbitrary and the resulting position of the blend uncertain. About all we

may say of the wave-lengths given is that they are homogeneous and that the scale is not very different from Rowland's. It is doubtful if they would suit another star unless it were exactly of the same type. The results from several late type stars, whose orbits have been computed at this observatory, seem to show that the apparent wave-lengths of blends as measured on low dispersion plates vary markedly with a slight variation in the spectral type.

The usual method, of first finding approximate elements and then correcting these differentially, was followed. One correction was found sufficient. The observations and the results are given in Tables II. and III. In the radial velocity curve the initial date is Julian Day 2420500.

TABLE II.

LICK AND POTSDAM OBSERVATIONS

Observatory	Julian Day	Phase from J. D. 2420500	Velocity	O-C
Lick	2,417,362·820	254·02	− 39·8	+ 4·9
Lick	7,617·998	85·30	− 11·7	+ 5·8
Lick	7,664·976	132·28	− 10·1	+ 5·8
Lick	7,687·924	155·23	− 12·3	+ 5·8
Lick	7,725·799	193·10	− 18·6	+ 4·9
Potsdam	8,818·46	14·06	− 23·3	+ 8·1
Potsdam	8,839·39	34·99	− 32·7	+ 7·3
Potsdam	9,572.38	132·13	− 12·5	+ 3·4

Table III.

OTTAWA OBSERVATIONS

Plate	Obs.	Date	Julian Day	Velocity	O-C
		1915			
6792	C	Feb. 17	2,420,546·821	− 40·0	+ 8·0
6825	H	Mar. 1	558·876	− 46·5	+ 2·1
6849	H	Mar. 8	565·724	− 30·8	+ 7·2
6866	Y	Mar. 14	571·710	− 32·3	− 3·8
6882	Y	Mar. 19	576·713	− 20·9	+ 1·6
6889	Y	Mar. 23	580·713	− 21·8	− 2·3
6895	H	Mar. 29	586·705	− 14·0	+ 3·0
6904	Y	Apr. 4	592·691	− 28·5	− 13·0
6908	Y	Apr. 7	595·724	− 11·4	− 3·8
6917	P'	Apr. 12	600·785	− 23·1	− 8·3
6922	Y	Apr. 13	601·705	− 16·7	− 1·9
6937	P'	Apr. 20	608·861	− 12·2	+ 2·4
6958	Y	Apr. 28	616·676	− 12·5	+ 2·3
6969	H-Y	May 6	624·715	− 15·3	0·0
6988	H	May 13	631·697	− 12·2	+ 3·4
7008	Y	May 23	641·708	21·9	− 5·2
7018	Y	May 27	645·756	− 19·5	− 2·4
7029	Y	May 30	648·665	− 13·0	+ 4·4
7049	Y	June 6	655·599	− 26·6	− 8·4
7059	P	June 16	665·613	− 12·9	+ 6·5
7068	Y	June 20	669·649	− 17·4	+ 2·6
7076	Y	June 27	676·642	− 24·6	− 3·6
7088	H	July 8	687·643	− 22·5	+ 0·1
7111	Y	July 20	699·580	− 28·4	− 3·7
7126	Y	July 27	706·580	− 22·6	+ 3·6
7139	H	Aug. 5	715·570	− 27·4	+ 0·8
7146	Y	Aug. 10	720·561	− 34·0	− 4·8
7158	Y	Aug. 17	727·562	− 34·9	− 3·1
7168	Y	Aug. 26	736·544	− 38·3	− 3·1
7193	H	Sept. 2	743·546	− 41·3	− 3·0
7228	Y	Sept. 10	751·500	− 43·2	0·2
7257	C	Sept. 17	758·524	− 43·1	+ 4·6
7271	Y	Sept. 21	762·512	− 48·7	+ 1·0
7281	H	Sept. 22	763·508	− 51·9	0·8
7285	H	Sept. 27	768·508	− 48·7	+ 1·4
7291	Y	Sept. 28	769·493	− 54·3	− 4·6
7317	Y	Oct. 3	774·486	− 47·4	− 3·4
7321	Y	Oct. 8	779·469	− 34·7	− 0·2
7326	Y	Oct. 10	781·474	− 28·6	+ 2·9
7340	Y	Oct. 15	786·470	− 27·9	− 3·1
7355	Y	Oct. 21	792·462	− 17·0	+ 2·5
7359	H	Oct. 23	794·458	− 18·2	+ 0·3

P = Plaskett. H = Harper. P' = Parker. C = Cannon. Y = Young.

The final elements are :

T =	J.D. 2,420,561·18	± 0·90 days.
K =	18·02 km.	± 0·59 km.
ω =	223°·42	± 2°·60
e =	0·54	± 0·024
γ =	− 25·62 km.	± 0·45 km.
P =	211·95 days	
μ =	1°·6985.	
$a \sin i$ =	44,000,000. km.	
$\frac{m_1^3 \sin^3 i}{(m+m_1)^2}$ =	0·076 ⊙	

The individual observations were represented by these elements and the residuals are given under the heading O–C. The Lick and Potsdam observations are very consistently positive. Part of this difference may be due to the scale of wave-lengths but some other factor must operate also.

The residuals from our own measures are often very large, in one case 13 km. The agreement of the individual lines would lead one to expect a probable error for a single plate between 0·5 and 1 km., whereas it actually came out 2·8. The measures were so discordant that an investigation was undertaken to try and locate some reason for the erratic manner in which the velocities behaved.

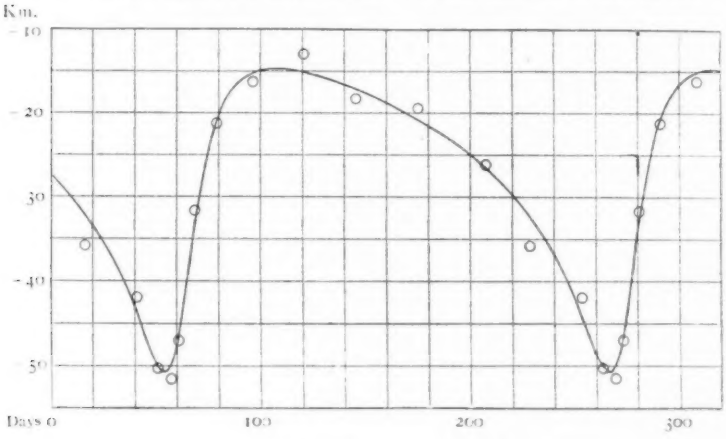
Part of the trouble may lie in the star itself, the conditions there changing irregularly so as to alter the apparent wave-lengths of the lines. The effect of such changes is small, for the higher the dispersion employed and the more perfect the method of observation the smaller do the variations in velocity become. This is practically conclusive evidence, so far as one-prism work is concerned, that the anomalies in velocities, for good line stars at least, arise within the spectrograph.

Flexure, temperature change, poor focus, irregular guiding, non-uniform illumination of the collimator, each of these plays its part in the final result. The first three causes have been well met and the modern spectrograph is almost mechanically perfect

and free from these defects. With good focus the danger from non-uniform illumination of the collimator vanishes.

The effect of guiding was tested by taking plates of Arcturus, placing the stellar image first on one side of the slit and then on the other. The results of these experiments were published in the *Publications of the Astronomical Society of the Pacific*, August, 1915. They showed that velocities as much as 13 km. from the truth could be obtained by guiding with the star not perfectly central on the slit. When one remembers that the guiding is done by blue-green light while the plate registers the blue and violet light and that the images of the star in these colors do not coincide, one can readily see that error could be introduced in this way. There are other considerations which lend plausibility to the suspicion that this source of error is very important. It would be larger in one-prism than in three prism instruments; it would be larger the smaller the telescope, for with a small objective the guiding image is fainter, the power is lower and consequently it is more difficult to bisect the star with the slit of the spectroscope. It would be larger in short-focus than in long-focus telescopes because the latter require more frequent attention in guiding and the image is shifted often from place to place so that in the mean the whole slit is better covered. Moreover, the effective image (the tremor disc) is larger for long-focus instruments so that a slight displacement of the star probably affects the centre of intensity of the image less than the same displacement in a telescope of shorter focus. These latter factors I believe to be very important. With the short-focus instrument used at this observatory and a clock which runs very uniformly a star will often stay in position for fifteen minutes. This fact, often coupled with a temperature in the dome in winter as low as -20°, when to place the eye to the guiding telescope is to receive the sensation of an electric shock, does not contribute to constant attention to the position of the star image on the slit. One might have a personal equation in bisecting the star image so that a run of plates would all be consistently too high or too low. Part of the difference between the Lick and Potsdam

observations and the Ottawa observations might be accounted for in this way. Experiment to ascertain the best method of guiding to secure consistent results would probably be worth while. Thus it might be found that slight illumination of the slit so that it could be seen without the aid of the star's light would add to the accuracy. Personally I find guiding easier in the twilight than on a dark night. In the case of *A* Boötis the



RADIAL VELOCITY OF *A* BOOTIS

majority of the latter half of the plates were taken under these conditions and in general they give smaller residuals than the early plates, but the evidence is not sufficient to show whether this is to be ascribed to the twilight or not.

DOMINION OBSERVATORY,
OTTAWA, CANADA,
December, 1915.

AURORA, EARTH CURRENTS AND MAGNETIC DISTURBANCES

By Otto Klotz

THESE may all be treated as a common subject or phenomenon. Let it be stated right at the outset that our ignorance of them is still vast.

The following despatch from Winnipeg on June 17 last, is so interesting that it is inserted in full, besides giving an opportunity for explaining some of the statements made therein :

Aurora, more mysterious than wireless telegraphy, less constant than the visible manifestations of electrical storms, is to-day tangling up all the telegraph wires strung across the top of the continent, more especially those along the north shore of Lake Superior. There has not been such a complete tie-up in the telegraph business between eastern and western Canada for a long time, and possibly records for the month of June might be searched for many years back without finding a parallel. In fact, well conducted auroræ confine themselves to the fall and winter months, and of all the months in the year June is most immune. The record of observations is Scandinavia and Iceland, as well as the Spitzbergen Station, show no aurora at all in June, though on the North American continent it is not an unknown, though still a rare June phenomenon.

Aurora manifestations are almost entirely confined to night, and these manifestations, whether visible or not, are commonly accompanied by magnetic earth currents, and it is these properly that affect the wires. Usually with the morning sun the whole manifestation lifts, wires surcharged with excessive and variating currents are freed and released for their daily business, and the atmosphere, overloaded with electricity, becomes normal. But to-day the magnetic storm, potent though both unseen and unheard, is raging as furiously, to the tune of crackling wires at noon, as it was at midnight. The sky is heavy and overcast. When the clouds lift and sun breaks through, the whole trouble will vanish magically as it came. For generations scientists have sought the secret of aurora and earth currents but have learned little beyond the central fact of the inconstancy of all available data on the subject.

Another peculiarity of the present visitation—a scourge alike to the telegraph companies and the daily newspapers—is that, whereas usually it is only wires running east and west that are affected by the polar visitant, on this occasion wires running north and south, such as those between Winnipeg and Minneapolis,

are affected to nearly the same extent. From the meteorological point of view, this magnetic storm adds one more to the queer performances of the current month of June.

The first and natural question to occur to an observer beholding the aurora, a brilliant aurora with its dancing, shooting streamers; building, forming and dissolving; rushing from its northern arch to meet beyond the zenith; clothed, perhaps, in greenish gauzy drapery or yet in portentous red; ceaseless activity, a mysterious phenomenon, bewildering to mind and brain — what is the aurora? Beholding it, gives no answer, but when we compare the phenomenon with associated ones we learn a little of its nature. We find it to be electric in its nature, an electric discharge. But here our positive knowledge about its nature stops.

We may mention the theories that have been advanced to account for the aurora. Birkeland attributes the phenomenon as due to cathode ray emanating from the sun; Nordmann replaces the cathode rays by Hertzian waves; and Arrhenius supposes negatively charged particles to be sent out by the sun and reaching the earth, ionizing the upper regions of the atmosphere and thereby making it a good conductor for electrical discharges. The cathode rays we know travel at about a tenth of the velocity of light, hence would take nearly an hour and a half to reach us from the sun; the Hertzian waves travel at the velocity of light, *i. e.*, 186,000 miles a second; and Arrhenius' particles would take about 46 hours, about two days, for transmission. The transmission time forms an important factor when an attempt is made to associate particular sun spots and solar outbursts with particular auroræ and magnetic disturbances. The solar effect is, that the discharge of the difference of potential on the earth is greatly facilitated; we have an electric current established with its consequent phenomena of auroræ, earth currents and magnetic disturbances. These are all more or less influenced by local conditions on or in the crust of the earth, and hence vary in intensity at different places. However, the strong currents encircle the earth, as we see in some notable

cases, and manifest themselves particularly in magnetic disturbances and earth currents.

The electrical discharges, for, of such are the auroræ, where do they take place? Many measurements and photographs (Stormer) have been made of the aurora to determine its position — height — in our atmosphere, and it has been found that the height, although varying considerably, is of the order of 50 miles. At that elevation the atmospheric pressure is only about 1/500 of an inch, about the pressure in a Geissler tube. The discharge of electricity through highly rarefied gases and vapors in the large tubes, with the accompanying glow, at the Centennial Exposition, in 1876, impressed the writer at the time with its close analogy and resemblance to the aurora or northern lights.

We may look upon the sun, not as the source of the magnetic disturbances, but as the medium that sets loose the bound energy residing in and on the earth.

It will generally — although not always — be found that the centre of the aurora-arch, if there be one, is in the magnetic meridian. In eastern Canada and the eastern United States this will be west of the true or astronomic north, while west of Lake Superior to the Pacific it will be east of the true meridian. Furthermore, if the streamers ascend from the north towards the zenith or beyond it, it will be found that their focus or meeting place is beyond or south of the zenith, and at a point approximately where the direction of the dipping needle intersects the celestial vault. We see here then a pretty close connection between the aurora and compass and dipping needle, which we know otherwise to exist. It is fairly safe to say that there is never a bright auroral display without an accompanying magnetic storm, and for which many cases might be cited. The inverse of the statement — that with every magnetic storm we have auroral display — is not so obvious, because the magnetic instruments are always at work, being self-registering, independent of day or night, while the aurora is a matter of visibility, and hence observations are relegated practically to the night. Here

we may cite a most interesting case—that of the great auroral display and great magnetic storm of June 17 last. Professor E. E. Barnard, in *Nature* of July 15, gives a vivid description of the aurora as seen at the Yerkes Observatory. The maximum brilliancy was reached shortly after 2 a.m., Central Standard Time, and shortly afterwards dawn blotted out further observation. While the aurora was pursuing its magic performances in the heavens the magnetic instruments all over the world were mightily perturbed, and as we know from the Winnipeg despatch quoted and other press reports, the telegraph lines were more or less demoralized by the atmospheric electric currents. While dawn was breaking with us, night was approaching in New Zealand, so that this world-encircling phenomenon could be observed there after daylight had made it invisible in America. And this is what happened. While it was mid-summer with us, at Dunedin, latitude 46° south, longitude 170° 30′ E. or $11^h\,22^m$ ahead of Greenwich, it was mid-winter, and the sun set before 5 p.m. Standard Time in New Zealand is fast on Central Standard Time $17^h\,30^m$, so that 2 a.m. quoted by Barnard would be 19.30 or 7.30 p.m. in New Zealand.

Mr. W. E. McAdam, of Dunedin, writes:

> Upon that day (June 17) there was an exceptionally fine display of the Aurora Australis visible all over New Zealand. Here, at Dunedin, it commenced at 7.30 p.m. and lasted till midnight. The glow in the southern horizon was quite uncanny in effect, producing the illusion that the sun was about to rise in an impossible quarter of the sky, and at an impossible hour. I have been resident in the Southern Hemisphere off and on for fifty years, and have never seen anything to equal the last display of the Aurora Australis, a somewhat rare phenomenon, in the latitude of Dunedin, 46° south.—(*Nature*, September 30, 1915).

This is a most interesting case, showing that while the "movies" became invisible in Canada, the night of New Zealand revealed their continued presence.

The aurora does not distribute its favors equally over the earth. The tropics and semi-tropics are practically devoid of them. The curves of equal frequency dip considerably farther south in America than in Europe. No country is so favored by this ethereal visitant as is Canada. From what has been said it

is obvious that more auroræ will be seen and are seen during the winter months than during those of the summer, simply because in the former case the nights are longer and consequent visibility of the aurora, if there is one.

The aurora has often the appearance of filaments or streaks of clouds, but the distinction is readily observed by the presence of a star or stars behind ; for the transparency of the former dims but little, if any, the brightness of the star, which by the latter, even if filmy, would be more or less obliterated.

In tabulating sun-spots and the frequency of auroræ over a long period of years, it is found that there is a very general agreement between the maxima of the one and the maxima of the other, and similarly between the minima, but the definite relationship between the two is not known. Auroræ, magnetic disturbances and earth currents are simultaneous phenomena due to electric currents in the higher regions of the atmosphere. Their individual intensity is to a degree dependent on local conditions, such as difference in geological formations, and all follow in a general way the sun-spot cycle of eleven years.

In examining the spectrum of the aurora it is found that there is one rather prominent line in the yellow-green wave-length 5571, which co-incides with a prominent line in the spectrum of krypton.

The writer has seen many auroræ in our North-West, their home, and has conversed with Hudson's Bay Co. officers and voyageurs, from whom information is said to have been obtained that noises have been heard during auroral displays, and which has been quoted in books and articles on the subject, yet the writer is convinced that there is no authentic record of any noise ever having been heard, although subjectively the "noises" may have been *felt*, as was the case, I am sure, with Ogilvie's man.

The interference of earth currents with the working of telegraph and cable lines is largely overcome by making a metallic circuit and, thereby, cutting out the earth. This, of course, reduces the capacity of the service.

Professor Barnard reports that signals on June 17, during

the aurora display, on the wireless receiver at the observatory were not affected, and that the static conditions were normal.

With reference to earth currents and cables, the writer may be permitted to quote extracts from his official report in 1892, in connection with the trans-Atlantic determination of longitude. At that time there were ten cables across the Atlantic, but when earth currents set in they are not all equally disturbed, in fact, sometimes some of the cables not at all. The French cable from Brest to St. Pierre seems to be disturbed the most, and again the disturbances are felt to a greater extent at St. Pierre than at Brest. It often happens that St. Pierre can send messages to Brest but cannot receive any. Long cables seem to be more affected than short ones, and, furthermore, the earth currents appear to travel mostly from east to west. When the aurora is visible, it is pretty certain that earth currents will show themselves. Thunderstorms and they, however, do not seem to be so closely related, if at all. During the past season (1892) on July 16, there was a remarkable disturbance noticed at Canso, stopping all work completely. The greatest "kick," as it is called, was given at 12.20 p.m., E.S.T., or 5.20 G.M.T. Some weeks afterwards reports came in the technical journals, from Brest, Malta, Cairo, Madras and east to Singapore of a similar disturbance on that day. Cairo, Egypt, fortunately stated the time, and from it, it was found to have been simultaneous with that of Canso. On August 24 (1892), strong earth currents set in at Canso, and at the time there was a marked auroral display. The southern cable (Commercial Company) was far more affected than the northern one. As most of the companies have two cables, they can generally get rid of the effects of earth currents by looping the cables together, that is, by making a metallic circuit. Sometimes the earth currents are so strong as to injure the condensers. From the direction of the cables it is noticed that cables running east and west are more troubled with these currents than cables running north and south. There is, however, a wide difference on east and west lines. The superintendent at St. Pierre told me that he experienced more earth

currents in the past two years (1891, 1892) at that place, than in the preceding eighteen years at Torbay and Canso, N.S., and besides that they are felt more on the American than on the European side. And furthermore:

> The cable is quite unprejudiced and shows equal favor to positive or negative gallantries. They are of the most erratic nature; sometimes they take off their things and make quite a visit, one, two or three days, varying greatly in their demonstrativeness during the time, but seldom getting so bad as to totally stop traffic. Sometimes they favor us with a two or three-minute call only, as if to remind us that they are still alive. They fluctuate in degree very greatly. The strength or electro-motive force of these earth currents has run up to 500 volts.

We have now said considerable about the subject of this paper, yet have, undoubtedly, failed to answer all the questions of the "practical" man. The practical man wants the aurora, earth currents and magnetic disturbances stopped, for they interfere with his work; the scientist doesn't want them stopped for they are a stepping stone leading upwards towards unravelling the grand mechanism of nature. All life, all activity, all energy of the earth, we may trace back to the sun, and until his secrets are revealed we shall remain in ignorance of much that is going on, on our globe. At present our hopes are especially centred on Mount Wilson, where Professor Hale and his assistants are bending all their energies upon our central orb. They intercept every messenger coming from the sun and put him through a rigorous examination, what his business is, and what despatches were entrusted to him before he left home. All these despatches are written in hieroglyphs, and only for a few, as yet, has a Rosetta stone been found for their interpretation. No gained ground is ever lost by the scientist, he is ever on the offensive. Of the messengers sent out by the sun, the earth intercepts but a very small portion; less than one two-thousand-millionth.

Until some of these messengers have been made to reveal their secrets, until then, we can only conjecture as to the why of the aurora, earth currents and magnetic disturbances.

DOMINION OBSERVATORY,
OTTAWA, CANADA
October 23, 1915.

ORBIT OF THE SPECTROSCOPIC BINARY α TRIANGULI*

By W. E. Harper

THIS star ($\alpha = 1^h\,47^m$, $\delta = 29°\,6'$) was announced as a spectroscopic binary in Lick Observatory *Bulletin* 199 from the measures of six plates giving a range in velocity of about 30 km. It was placed upon our observing program in January, 1913, and twenty spectrograms had been secured in 1913 and 1914 before an investigation of its orbit was undertaken by the writer. The spectrum is of type *F*5; the lines are diffuse and ill-defined and consequently the measured velocities may be considerably in error. When the twenty plates had been reduced without any greater range being found than that announced, it was felt that, if the period was to be obtained, results upon which more dependence could be placed than that furnished by a single plate would have to be secured. Consequently, it was decided to make at least two plates each time the star was spectrographed and this procedure has been carried out in the present autumn. The star is of photographic magnitude 4·1 and thirty minutes or less is sufficient to get a measurable plate.

Eighty-five plates in all have been secured and upon these the determination of the orbit is based. Three different combinations of the single prism have been used, but the great bulk of the observations have been secured with the present arrangement of the single prism with a dispersion at $H\gamma$ of 32·8 Å. per millimetre. Owing to the uncertain character of the lines in the spectrum the wave-lengths have not been corrected in the customary manner of equating the residuals to zero. Were such corrections made the agreement of some of the observations with

*Will appear in more detail as a Publication of this Observatory.

the curve would be slightly improved, but on the whole no material difference in the elements would be produced.

The period was found from the September and October, 1915, observations to be around 1·74 days. Our 1913 and 1914 observations changed this to 1·7365 days. To bring the Lick observations into the best agreement, this value was further changed to 1·73652 days which seems the only permissible value. As some 3600 revolutions have occurred in the interval between the dates of the first plate and the last, the fifth decimal place in the period should be significant. The Lick observations are more positive than our own by about 5 km. In quite a number of stars of late we find our own observations from 3 to 5 km. more negative than those of the Lick Observatory. From time to time spectrograms of Arcturus are made as a check upon the instrument, so the difference is probably mostly in the wave-lengths used. There is a possibility that in this case the difference represents a real change in the velocity of the system as our 1913 observations have likewise systematically positive residuals. The evidence, however, does not seem sufficient to state definitely that such is the case.

The Ottawa observations were grouped according to phase into 12 normal places and preliminary elements graphically determined. Very small corrections resulted from the least squares solution, but the sum of the residuals for the normal places was reduced from 11·1 to 6·2. The probable error of a plate was found to be ± 3·5 km. per sec. which is much lower than expected.

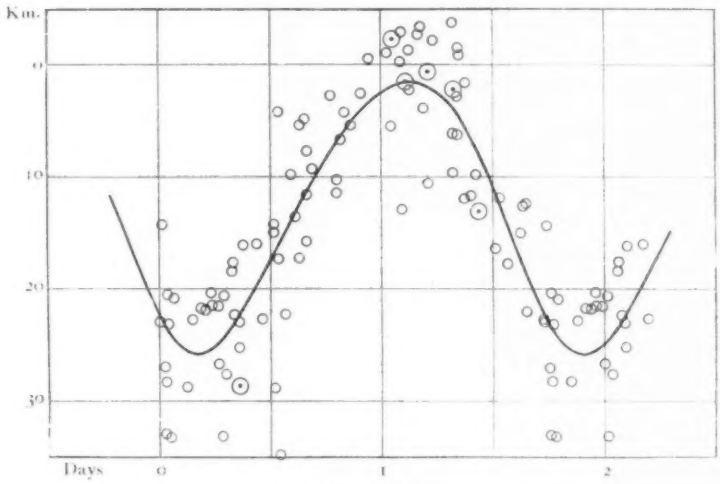


FIGURE I.

OBSERVATIONS OF α TRIANGULI

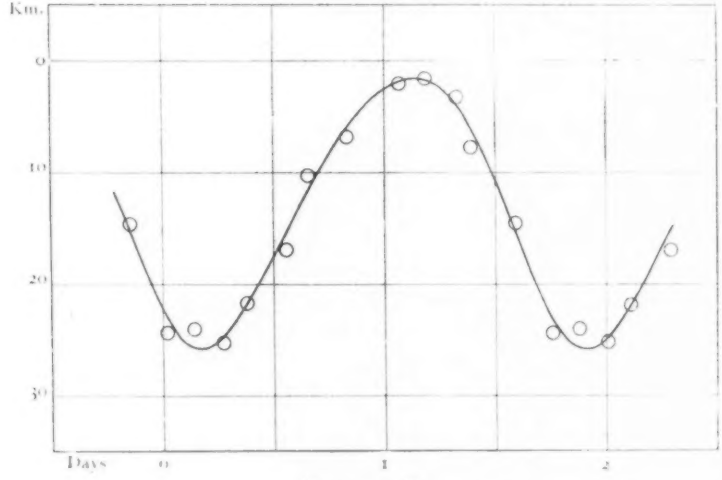


FIGURE II.

VELOCITY CURVE OF α TRIANGULI

The following are the final elements:

P = period,	1·73652 days	
e = eccentricity,	·121	± ·041
ω = longitude of periastron,	135°·56	± 23°·35
K = semi-amplitude,	12·10 km.	± ·46 km.
γ = velocity of system,	−12·65 km.	± ·36 km.
A =	11·05	
B =	13·15	
T = periastron passage,	J.D. 2,414,552·768	± ·105
$a \sin i$ = projected semi-major axis,	286800 km.	

Figure I. shows the individual observations, the circles with dark centres representing the early Lick observations with − 5·0 km. added to each; Figure II. shows the grouped observations.

Dominion Observatory,
Ottawa, Canada.
November, 1915.

MEETINGS OF THE SOCIETY

At Toronto

November 16, 1915.—A regular meeting of the Society was held in the Rooms at 198 College Street, at 8 p.m. Dr. C. A Chant in the chair.

Under "Reports of Observations" Dr. Chant described having seen Mercury very clearly on the Friday before, and Mr. J. P. Henderson, a good Aurora last evening.

Questions were asked about the height of auroræ above the earth, the strength of their luminosity, and the "atmosphere" or surrounding of the sun.

The paper for the evening was then given by Mr. F. L. Blake, on "Sun-Spot Records." Mr. Blake explained the method he uses for making records of the spots by means of the 6-inch telescope of the Meteorological Observatory, and then referred to the number of spots which had been visible during the past months and showed how we are approaching a sun-spot maximum.

Various other phenomena connected with the sun-spots were also discussed, including their photography by ordinary camera and by the spectroheliograph. Mr. Blake also explained the connection between sun-spots, auroræ and magnetic disturbances.

November 30.—A regular meeting was held in the Rooms at 198 College St., at 8 p.m. Vice-President Dr. A. D. Watson, in the chair.

Wm. Dawson, 66 Richmond St. E., was duly elected a member of the Society.

Mr. A. F. Hunter drew attention to a recent paper by Dr. Pring, of Manchester, on the blue color of the sky, and to the address of the Astronomer Royal at the recent meeting of the British Association, dealing with the the advance in stellar work during the past ten years.

A number of other references were made by other members, to notes of interest appearing in current publications.

There were two short papers for the evening by Professor Chant. The first dealt with the temperature conditions prevailing on the top of a mountain and at its base: the second dealt with the height of the Aurora and was accompanied by a number of slides of pairs of photographs of the phenomenon taken in Norway by Störmer.

December 14.— A regular meeting of the Society was held in the Rooms at 198 College St., at 8 p.m., Vice-President, Dr. A. D. Watson, in the chair.

Rev. R. W. Norwood, Memorial Church Rectory, London, Ont., and Rev. D. W. Best, 399 Lansdowne Ave., Toronto, were elected members of the Society.

Mr. Wallace exhibited a 10-inch mirror, ground by himself in less than twenty-four hours.

The paper for the evening was given by Professor W. H. Day, of Guelph, on "Lightning, Its Nature and Means of Protection from It." The lecturer first traced the history of the growth of knowledge of electricity, illustrating his remarks by some simple experiments, and explained Dr. Simpson's work on the electricity of the thunder-cloud.

The efficiency of the lightning-rod was demonstrated by statistics from insurance companies gathered during 1912 and 1913 in Ontario, and for a number of years from companies in Iowa and Michigan. The percentage of efficiency was from 92½ to 99.

Experiments were made showing the benefits of lightning-

rods on buildings, and the effective methods of applying lightning-rods.

Many questions were asked which the lecturer answered very satisfactorily. Mr. A. F. Miller described a stroke of lightning which the Toronto General Hospital received during the last summer and exhibited some fragments of terra cotta and wood shattered at the time.

W. E. W. JACKSON, *Rec.-Sec.*

AT OTTAWA

October 29.—The First Meeting of the Fall Term was held to-day, at 3 o'clock, in the Lecture Room, Geodetic Survey Building, Dr. W. F. King presiding.

Mr. F. A. McDiarmid was called on to give his paper on "Gravity." After making some general remarks about Newton's Law of Gravitation, and the difference in the pull of gravity at the poles and equator (1 in 194), due to the oblate figure of the earth and the centrifugal force produced by its rotation, Mr. McDiarmid mentioned the work of Dr. Klotz in 1902 and of Professor L. B. Stewart in 1905, at various points in Canada, using the simple pendulum. He then described his own work in 1914, which began with a double comparison of gravity at Ottawa with Washington, which had been compared by Putnam with Potsdam where an absolute measure (980·112 dynes) had been made. Four determinations for Ottawa on this basis gave a mean of 980·615 dynes, with a range of 5 points in the last place. Mr. McDiarmid showed from his observations the effect of changing temperature in the pendulum case during an observation of 8 hours, pointing out how important it was to have constant temperature and pressure during the observation. The results for 1914 showed the necessity of handling the pendulums carefully during transport. The 1915 observations with all of these variables under control, showed a high degree of accuracy. Three half-second pendulums, (Nos. 1, 2, 3), were used to determine the periods ($t = \pi \sqrt{l/g}$). The mean difference at 12 stations between Nos 2 and 1 was, 0·00001196 sec. with a range

of 9 in the last decimal place; while the differences between 2 and 3 for the same 12 stations showed a mean of 0·00000312 sec. with a similar range. It would appear that the determinations of the period of a pendulum were accurate to the ten-millionth part of a sec. The direct telegraphic connection with the Dominion Observatory standard clock partly accounts for this great degree of accuracy.

Several points of the lecture were discussed. The hearty thanks of the Society were tendered Mr. McDiarmid; after which the meeting adjourned.

November 12.—The Second Meeting of the term was held this evening in the Carnegie Public Library, Mr. F. A. McDiarmid presiding.

The Chairman then called on Mr. R. E. DeLury to give his lecture on "Sun-Spots."

Lantern-slides of spots photographed on successive days were shown to illustrate the changes that take place in the appearance of spots and to indicate the speed of the sun's rotation. Spectroheliograms of the sun's surface and of prominences of different types were thrown on the screen. It was explained how the nature of the magnetic fields in spots were determined and also how, by measuring the displacements of the spectrum lines of different intensities, velocities towards and from the axis of the spot were determined for different levels. Charts showed the periodicity of sun-spots and the accompanying periodicities of auroræ, terrestrial magnetic disturbances, temperature and rainfall. It was pointed out how, since vegetation depends on rainfall, it should be possible by measuring the annual growths of old trees, to get data bearing on sun-spot changes back hundreds of years before they were systematically observed. This information would help in deciding upon the theories of the cause of sun-spots, some of which were mentioned. Hale's vortex theory of spots was explained with the aid of a diagram.

The Chairman presented the hearty thanks of the Society to the lecturer, after which the meeting adjourned.

November 19.—The Third Meeting of the Term was held in the Geodetic Survey Building to-day, at 3 o'clock, Mr. F. A. McDiarmid presiding.

Mr. Alex. B. Cowan, of Ottawa, proposed at the last meeting, was duly elected a member of the Society.

The subject for the afternoon was, "The San Francisco Meeting of the A. A. A. S.," Dr. Klotz dealing with the proceedings of the Seismological Society and Mr. R. M. Motherwell with the Astronomical Society.

Dr. Klotz briefly outlined the history of the American Association for the Advancement of Science (founded 1848), after referring to its predecessors the Royal Society (1660), the French Academy (1665), the British Association for the Advancement of Science (1821). He then dealt with the four papers presented at the Seismological Section, one of the latest members of the general Association. Professor McAdie, in his presidential address, spoke particularly about "A Standard Scale of Earthquake Intensity"; Professor de Ballore, on "Parallel Shelf Faults"; Professor Branner, on "Co-Ordination of Earthquake Data"; Dr. Klotz, on "Practical Seismology," "Microseisms," "The Undagraph," and "Deformation Instrument."

Mr. Motherwell gave a general outline of the meetings held by the Astronomical Section and the various receptions and excursions. He dealt specially with the papers by Hale, "On the Work of a Modern Observatory"; Townley, on "The Designation of Variables"; Barnard, "Photographs of the Milky Way Showing Dark Gaps"; Miss Harwood, on "Eros' Rotation Period" (0·1098 days in 1903 and 0·3064 days in 1914); Professor Aitken, on "Double Stars"; and papers on "Parallax" and "Nebulæ." The presentation of the Bruce Medal to Dr. Campbell was mentioned.

The thanks of the Society were presented to Dr. Klotz and Mr. Motherwell; and the meeting adjourned.

December 3.—The Fourth Meeting of the Term was held

this evening in the Carnegie Public Library, Mr. F. A. McDiarmie in the chair.

The Chairman called on the speaker of the evening, Dr. Albert D. Watson, of Toronto, to give his lecture on, "The Companions of the Sun."

Dr. Watson presented a very vivid picture of the Solar Family, dealing in detail with each planet and discussing the possibility of life on some of them. The earth and its phenomena received a considerable treatment; the auroræ and meteors and the noises made by these (reported to have been heard by the lecturer and others) and the flight of meteors in February, 1913, were given special prominence. The asteroids, especially Eros, the moons, comets in general, the scale of the Solar System and its great distance from other such systems were carefully discussed. Lantern slides were used to illustrate the lecture. Dr. Watson read, by request, his poems on "The Comet," "The Northern Lights," and "Kepler"; and these gems of verse was much admired. A refreshing feature of the lecture was the absence of technical words. The explanations were made perfectly clear by simple, beautiful language and the large audience, among whom were many non-members, greatly appreciated the lecture of our Omar.

The hearty thanks of the Society was tendered the lecturer after which the meeting adjourned.

R. E. DELURY, *Sec.*

AT HAMILTON

December 17.—The Annual Meeting of the Hamilton Centre was held in the Rooms of the Society.

The Secretary's report showed a continuance in the interest taken in the work of the Society, and that of the Treasurer, a fair balance on the right side of the account. (These will appear in the Report of the General Annual Meeting of the Society).

The election of officers having been concluded, Mr. J. M.

Williams, President-elect, moved that the retiring President, Mr. Wm. Bruce, on account of his four years' hard work as Local President be made Honorary President of the Centre, on being seconded by T. H. Wingham, the motion carried.

The Rev. J. J. Morton, who occupied the chair, then called upon Dr. Albert D. Watson, of Toronto, who delivered an address on "Companions of the Sun."

With the aid of lantern slides the lecturer described the various planets, their phases, motions and attendant moons, also their comparative sizes and densities, especially paying attention to Mars with its "Canals" as the possible abode of life.

At the close Dr. Watson was kind enough to read several of his poems on astronomical subjects.

T. H. WINGHAM, *Sec.*

COMET NEWS

Harvard College *Bulletin*, 592, dated December 6, 1915, announces that the discovery of a comet by Taylor, at Cape of Good Hope, near δ Orionis.

Positions were reported in subsequent *Bulletins* as follows :

G.M.T. 1915	R.A. h m s	Decl. ° ′ ″	Observer	Place
Dec. 5·6957	5 22 42·9	+0 01 36	Burton	U.S. Naval Obs.
6·7597	5 22 40·31	+0 02 10·5	Van Biesbroeck	Yerkes Obs.
7·6577	5 22 11·58	+0 12 06·4	Wilson	Northfield, Minn.
7·7719	5 22 07·5	+0 13 24	Van Biesbroeck	Yerkes Obs.
7·8892	5 22 04·7	+0 14 37	Aitken	Lick Observatory.
8·7004	5 21 36·8	+0 24 05	Burton	U.S. Naval Obs.

The comet was visible in a small telescope.

In *Bulletin* 595 is given the following elements and ephemeris, calculated by Miss Levy and Shane from observations on December 7, 8, 9 :—

ELEMENTS

Time of perihelion passage	(T)	1915, November 4·84, G.M.T.
Perihelion minus node	(ω)	315° 55′
Longitude of node	(Ω)	107° 44′
Inclination	(i)	27° 09′
Perihelion distance	(q)	2·543.

EPHEMERIS

G.M.T.	R.A. h m s	Decl. ° ′ ″	Light
1915, December, 12·5	5 19 25	+ 1 11	0·99
16·5	5 17 07	2 03	
20·5	5 14 53	2 50	
24·5	5 12 47	3 50	0·91

The orbit is stated to be uncertain. It will be seen that the comet is moving slowly north and west and it is well placed for observation during the evening. We hope to give in the next number, diagrams of the comet's path if the uncertainty of the orbit is removed in time.

NOTES FROM THE METEOROLOGICAL SERVICE

Summary Report of the Weather in Canada

November, 1915

Temperature.—The mean temperature of the month was above normal over the Dominion generally, but in Northern Alberta and some sections of Manitoba, it was about average, and over the greater portion of British Columbia it was from one to seven degrees below. Positive departures of three or four degrees were recorded in Southern Alberta, and of two to five degrees from Lake Superior eastward.

Precipitation.—The precipitation was below the normal over the larger portion of the Dominion. On the coast of British Columbia, however, the total ranged from 4·5 inches at Victoria to nearly 12 inches at Prince Rupert, and over the greater part of Nova Scotia it was also quite heavy, amounting to 6·6 inches at Halifax, and 8·4 inches at Sydney, which is considerably more than the normal for that district. In the Prairie Provinces the comparatively light fall was mostly in the form of snow, but from the Great Lakes eastward, while rain constituted the greater portion of the precipitation, snow in varying quantities was recorded in nearly all sections.

Depth of Snow on the Ground.—In Southern British Columbia and along the coast there was little or no snow on the ground at the close of the month, but in some interior districts in the northern portion of the Province there was a depth of 10 inches.

In Southern Alberta the ground was bare, while over Saskatchewan and Manitoba the depth varied between one and eight inches. In the northern districts of Ontario and Quebec there was a depth of one to six inches, and in the Counties contiguous to Lake Huron there was also a thin covering. Over the greater portion of southern and eastern Ontario, and southern Quebec, however, the ground was bare. In New Brunswick the snow that had fallen had disappeared before the 30th, while in Nova Scotia little or none fell during the month.

Temperature for November, 1915

Station	November		Station	November	
	Highest	Lowest		Highest	Lowest
Yukon			Huntsville	60	14
Dawson	32	26	Kenora		
British Columbia			Kinmount		
Atlin	40	11	Kingston	63	20
Agassiz	53	28	London	64	22
Barkerville	37	0	Lucknow	64	16
Kamloops	54	13	Markdale	62	12
New Westminster	53	25	North Gower		10
Prince Rupert	53	30	Oshawa	65	16
Vancouver	52	27	Ottawa	61	16
Victoria	54	33	Paris	65	21
Western Provinces			Parry Sound	58	12
Battleford	51	12	Peterboro'	58	16
Calgary	55	0	Port Arthur	54	12
Edmonton	53	3	Port Burwell	66	23
Medicine Hat	63	0	Port Dover	60	23
Minnedosa	60	5	Port Stanley	60	22
Moose Jaw	56	5	Queensborough	61	13
Oakbank	51	8	Ronville	56	15
Portage la Prairie	65	0	Southampton	63	16
Prince Albert	44	14	Sundridge		
Qu'Appelle	55	8	Stonecliffe	60	10
Regina	54	14	Stony Creek	65	20
Saskatoon	51	11	Toronto	61	24
Souris	62	7	Uxbridge	57	16
Swift Current	56	2	Wallaceburg	68	23
Winnipeg	53	3	Welland	65	21
Ontario			White River	55	9
Agincourt	59	15	*Quebec*		
Aurora	58	14	Brome	65	5
Bancroft	55	10	Father Point	42	12
Barrie	62	17	Montreal	64	21
Beatrice	59	15	Quebec	50	19
Berlin	63	18	Sherbrooke	62	16
Bloomfield	60	20			
Brantford			*Maritime Provinces*		
Chapleau	54	1	Charlottetown	50	22
Chatham	69	25	Chatham	52	14
Clinton	65	22	Dalhousie	47	15
Collingwood	65	15	Fredericton	58	17
Cottam	69	23	Halifax	64	28
Georgetown	61	18	Moncton	59	18
Goderich			St. John	52	24
Gravenhurst			St. Stephen	59	18
Grimsby	65	20	Sussex	55	19
Guelph	62	22	Sydney	58	24
Haliburton	58	11	Yarmouth	55	28

MAGNETIC OBSERVATIONS

November, 1915

During the month of November the record of the Magnetic Forces at Agincourt is indicative of great activity. Only on four days were the curves obtained classified as normal. Very active disturbances occurred on the 1st, 5th and 6th, and from the 16th to 19th. The most pronounced of these was on the 5th and 6th and began suddenly at $5^d\ 9^h\ 35^m$ with slight increases in the Horizontal and Vertical Components and slight decrease in westerly Declination. It was most active during the night hours of the 5th and early morning of the 6th when both maximum and minimum for the month were recorded. In both Horizontal and Vertical Force the maximum was registered at $5^d\ 20^h\ 04^m$ in each case and minimum at $6^d\ 2^h\ 38^m$ and $6^d\ 2^h\ 50^m$ respectively, with range in Horizontal of 597γ and in Vertical of €30γ. In Declination the maximum West was at $5^d\ 23^h\ 55^m$ and minimum at $5^d\ 20^h\ 36^m$ with range of 103′.

The storm of the 16th to 19th showed some rapid fluctuations in the Forces, which, however, were generally of no great amplitude. It was remarkable rather for its duration and a large diminution in both Horizontal and Vertical Forces, in Vertical amounting to about 25γ from the normal mean daily value which only returned to normal again by the end of the month.

Auroræ of the 1st and 2nd class were recorded generally in the Western Provinces on the 5th and 6th and at a few places in Ontario and Quebec; 3rd and 4th class auroræ were recorded from 16th to 21st mostly in the Western Provinces.

November, 1915		D. West	H	V	I
		° ′			° ′
	Mean of Month	6 30·5	0·15997	0·58595	74 44·7
	Maximum	7 31·3	0·16193	0·58868	
	Date of Maximum	5	5	5	
	Minimum	5 48·3	0·15596	0·58238	
	Date of Minimum	5	6	6	
	Monthly Range	1 43·0	0·00597	0·00630	
Mean Daily Amplitude	From hourly readings	0 8·2	0·00033	0·00032	
	From Means of Extremes	0 23·4	0·00095	0·00067	

H and V are expressed in C. G. S. Units.

I is the Mean of all Dip observations made during the month with the Earth Inductor, without regard to the time of day at which they are made. Two observations are usually made each week, one in the morning near the time of maximum Dip and the other in the afternoon near the time of minimum Dip.

W. E. W. J.

Earthquake Records by the Milne Seismograph

TORONTO

R. F. Stupart, Director.

P. T. = Preliminary Tremors, L.W. = Large Waves. A.C. = Air Currents.
Time is Greenwich Civil Mean Time, 0 or 24 h = midnight.

No.	Date 1915		P. T. Comm.		L.W. Comm.		Max.		End		Max. Amp.	Durat.		Remarks
			h m		h m		h m		h m		mm.	h	m	
1526	Nov.	1	7 47·8	S	8 13·3	/	8 24·2				8·0			Medium quake well defined.
			8 0·0		8 17·2	\								
1527	"	1			9 46·8		10 0·6		11 23·4?		1·0	3	35·6	Possibly a dual quake.
1528	"	18	A. C.		4 51·6	/	5 4·3		A.C.		0·3			A.C. going on.
					4 56·1	\								
1529	"	21	0 26·1	S	0 30·9		0 31·8		2 42·0?	/	5·9			Well marked.
							0 33·3	/	3 8·5	\	7·0			P. not recorded.
							0 33·6	\						S. California.
1530	"	22			5 46·8				5 48·4		0·1			Doubtful.
1531	"	26	19 22·8		19 31·3	/	19 35·4		20 1·0		0·7	0	38·2	P. doubtful.
			S-L 19 29·2		19 34·4	\								
1532	"	30	5 3·2	S	5 6·9		5 9·0		5 27·0		0·8			P. not recorded. S. doubtful.

Boom Period = 18 seconds. 1 mm. = 0″·50.

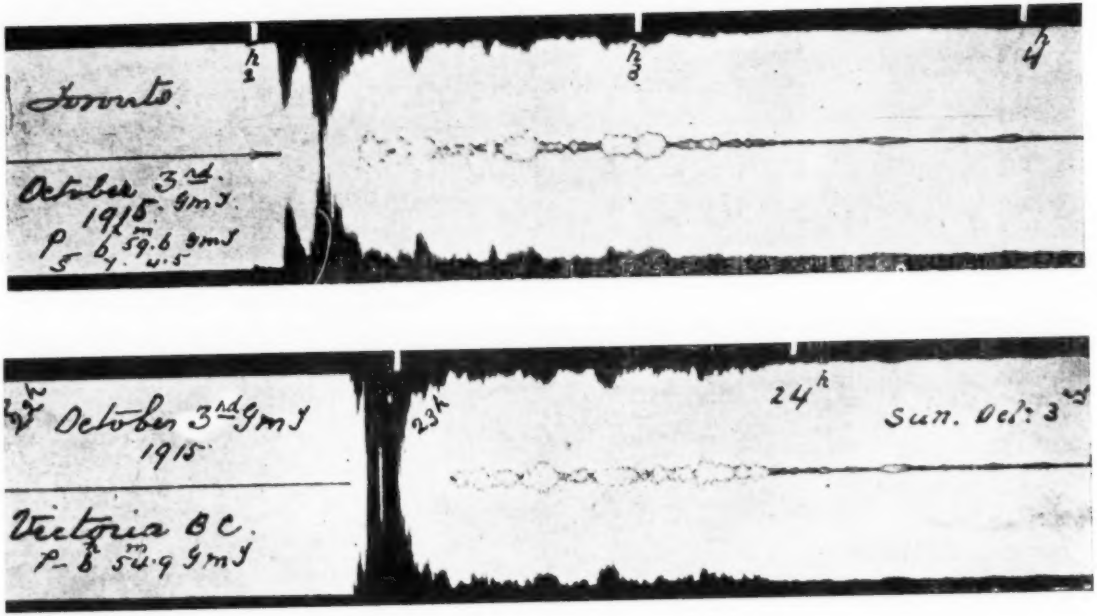
VICTORIA, B. C.

F. N. DENISON, SUPERINTENDENT.

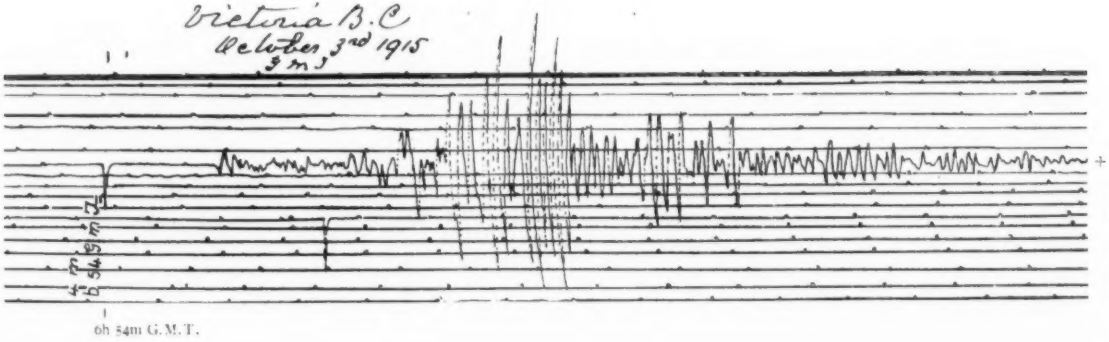
No.	Date 1915	P.T. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Durat.	Remarks
		h m	h m	h m	h m	mm.	h m	
1529	Nov. 1	S 7 34·0; 7 42·7	8 00·9	8 4·6		5		7,280 km. N. Japan
1530	" 1		9 38·6		11 10·1	0·3		May be dual quake.
1531	" 18	4 41·8?	4 44·3	4 44·8	4 49·3	0·1	0 7·5	
1532	" 20	15 39·0	15 40·0	15 41·5	15 43·0	0·1	0 4·0	
1533	" 21	S 0 14·6 0 17·9	0 20·8	0 23·4	1 00·5	over 28·0	0 5·8	1940 km. Almost across the paper. S. California.
1534	" 23	12 52·7	12 54·2	12 54·2	12 56·7	0·1	0 4·0	Doubtful.
1535	" 26		19 45·2) 19 49·9)					Light off at 19h 52·5m to attend instrument.
1536	" 30		5 14·6) 5 24·3?)			0·05		Cylinder or light jumping, measurements doubtful.

Boom Period = 18 seconds. 1 mm. = 0″·54

J. V.



NEVADA EARTHQUAKE



NEVADA EARTHQUAKE

Copy of Record by Wiechart Vertical Seismograph.

The marks on line represent intervals of one minute of time. A single line only is drawn by the pen on the recording cylinder as it revolves. + indicates that portion of the line on which the disturbance occurred.

ASTRONOMICAL NOTES

A CENSUS OF THE SKY.— We leave off our summation at a point where each additional magnitude is adding more stars than the last. If this went on, the number would be infinite. But, according to the formula, between the 23rd and 24th magnitudes there is a turning-point, after which each new magnitude adds less than before. The actual counts have been carried so near this turning-point that there is no reasonable doubt of its existence. Given its existence, the number of stars is at least finite. That is a conclusion that I regard as open to very little doubt. As to the value of the sum, naturally we can be less positive. But all the indications of the earlier terms must be misleading if the margin between one and two thousand millions is not enough to cover the whole.— PROFESSOR R. A. SAMPSON, in November *Observatory*.

PROPER MOTION OF NEBULÆ.— It is now about sixteen years since Director Keeler inaugurated his program of nebular photography with the Crossley Reflector. It was early realized that this collection of photographs of 104 nebulæ and clusters was in many respects a unique one in its epoch and extent, and that it would some day serve as a valuable basis for determination of nebular motions or changes. One of the programs of work at the Lick Observatory has been to repeat the early photographs in the search for such changes, and also to collect as many additional photographs of nebulæ as possible to form the basis of more extended motion determinations in the future.

This program of repetition is now practically completed. The average time interval between the early and the late plates is 13·85 years ; the total number of objects measured is 140.

Although astronomical literature is already all too full of deductions made from an insufficient number of objects, it may be of interest to use the confessedly meager body of data at present available to obtain an estimate of the distances of the planetary nebulæ and the large spirals.

The average radial velocity of 78 planetary type nebulæ from recent Lick observations is thirty-nine kilometres per second. This value, combined with the average proper motion found, would make the average distance of this class of nebulæ about one thousand light-years, a value which is not improbable, as all these objects are Milky Way phenomena.

The radial velocities of very few spirals have been determined as yet ; the mean of Slipher's results is 400 kilometres per second, a truly enormous value, which may be considerably changed when a larger number have been determined. On this basis and on the assumption that these objects are moving truly at random in space, the average distance of the spirals is of the order of ten thousand light years, a distance which many will regard as too small.— H. D. CURTIS, *Publications Astronomical Society of the Pacific*, December, 1915.

THE word Fellow is given in the dictionary as from O. E. *féo laga* (FEE, LAY), "one who lays down money in partnership." There is thus no need to limit its official use to one sex, presuming the women do their duty as fee-layers. But its unofficial use has strayed from the original considerably, so that it may yet be some time before the words "my dear fellow" become common property ; and longer still (let us hope) before the Pickwickian "Sir ! You are a fellow !" is used with the substitution of Madam ! for Sir !— From OXFORD NOTE-BOOK, in *The Observatory*, December, 1915.

J. R. C.

NOTES AND QUERIES

Communications are Invited, Especially from Amateurs. The Editor will try to Secure Answers to Queries.

QUERY

On page 27 of Eddington's "Stellar Movements and the Structure of the Universe" is the following:

"At Radcliffe Observatory 150 plates have been stored away undeveloped, ready for a second exposure after a suitable interval. . . . . ."

How long is that likely to be? Has the present generation any chance of hearing any of these results?—T. H. W. (Hamilton).

ANSWER

I do not know how long it is intended that the plates of the Radcliffe Observatory should be stored away, but it would be quite possible to get good results from a 10-year interval. The photographic telescope at Radcliffe is 24-inch and it is safe to assume that it gives a larger field than the Yerkes 40-inch even though the scale may be much smaller. So the probable error should be less than ± ·01", as Van Maanen had a probable error of ± ·0055 with the 40-inch for an interval of 10 years. Of course 15 years or 20 years would reduce the probable error greatly, but it is safe to say the plates will not be kept over 15 years and the present generation may count on seeing the results published. Owing to the fact that this method does not permit the use of plates or micrometer measures of earlier dates it prevents the use of all other material.

Kapteyn kept his plates for 8 years and found that several were useless on account of moisture, and many of the plates measured had very diffuse images from the first exposure. It

seems almost evident from his results, that 10 years would be the limit unless we had some way of keeping the plates *absolutely* dry.

However, there is much to be said on either side and very satisfactory results have been obtained. With extraordinary precautions the plates may be kept 15 years, but with ordinary care 10 years seems the extreme limit and even then we may look for trouble. It must be most discouraging to keep a plate 10 years or so and then find it useless.

R. M. MOTHERWELL.

DR. JOHN A. BRASHEAR'S 75TH BIRTHDAY

The excellence of the optical products as well as the public-spirited character of Dr. John A. Brashear have rendered his name widely and favorably known, and the readers of the JOURNAL will be pleased to have the following account of a meeting held in his honor, supplied, at the Editor's request, by Mr. C. J. Hudson, of the Allegheny Observatory:

The many friends of Dr. Brashear decided some time ago that his seventy-fifth birthday ought to be observed. During the summer he had been named by the Governor of the State "the most eminent living Pennsylvanian." This honor, with the three-quarter milestone of life safely passed, made the time particularly suitable. Accordingly plans were made for a dinner in honor of John Alfred Brashear on his seventy-fifth birthday anniversary, November 24, 1915, at Soldiers Memorial Hall, Pittsburgh, Pennsylvania.

Dr. Brashear welcomed some fifteen hundred of his friends at the entrance of the large banquet hall. Then came a good dinner, served in excellent manner. On the cover of the menu was a picture of Dr. Brashear, copied from a recent painting by Benziger, in the possession of Mr. Charles Schwab. Mr. Schwab announced that this portrait is eventually to be placed in Pittsburgh.

Many telegrams and letters from friends who could not be present were read. Those from President Wilson, Governor

Brumbaugh, Alexander Graham Bell and Mr. and Mrs. Carnegie were among the ones read.

The students of the Department of Dramatic Art of the Carnegie Institute of Technology gave a masque, sketching Dr. Brashear's life, especially showing his early interest in astronomy.

A pageant followed in which those marching carried banners of the different organizations to which Dr. Brashear belongs, and of the various colleges which have honored him with degrees.

The Phoebe Brashear Club paid a most beautiful tribute. The members formed a part of the pageant; each carried an American Beauty rose which was given to Dr Brashear in appreciation of what he had done for them. This Club also presented him a huge silver vase.

With his arms full of roses Dr. Brashear spoke. He told of his happiness in being surrounded by so many friends; but disclaimed all right to such a tribute, saying that he owed whatever success he is in life to his dear wife and to his son-in-law, Mr. MacDowell.

It was announced that a fund of $50,000 is being raised to be known as the John A. Brashear Lectureship Fund, the income of which is to be used to perpetuate the delightful lectures given by Dr. Brashear. $32,000 had already been given and the remainder is assured. Dr. Brashear is to be the incumbent of this lectureship during his life.

The evening was brought to a close by a few short speeches. The words "Uncle John" and "Pa" were used many times by his friends and served to indicate the high esteem and affection in which they hold him.

C. A. C.